ECE 575 Exam 1
Thursday, September 27, 2002

Do all questions. Open book.

Part I (35)

All questions relate to the DEVS formalism and DEVSJAVA.

1. A basic model specifies which of the following (circle all those that apply)
   a) input set
   b) state set
   c) elapsed time
   d) time advance function
   e) total state set
   f) output function

2. Every state has a finite positive time advance
T
F

3. In the usual approach to atomic models, sigma gives the
   a) elapsed time since the last event
   b) time advance for the current state
   c) time left in the current state
   d) both b) and c)
(circle the best answer)

4. The internal transition function is always called before the output function
T
F

5. The elapsed time clock is always reset to 0 after an
   a) internal event
   b) external event
   c) all of the above
   d) none of the above
(circle the best answer)

6. To retain the same time of next event you retain the same time advance after an internal transition
T
F

7. Circle all the following that have the exactly the same effect on the time advance

a) passivate()
b) Continue(e)
c) holdIn("passive", INFINITY)
d) passivateIn("passive")
e) add(delay)

8. A coupled model specifies components and

a) internal coupling
b) external input coupling
c) external output coupling
d) all of the above
e) none of the above

(circle the best answer)

9. Closure under coupling states that you can always define a ________ model that has the same behavior as a well-defined coupled model

a) jobQueue
b) basic
c) black box
d) DEVSJAVA atomic

(circle all that apply)

10. Closure under coupling is important because

a) it justifies hierarchical construction
b) its proof provides the rules governing simulation of coupled models
c) both of the above
d) none of the above

(circle the best answer)

11. A bag containing multiple contents can arise

a) when a component receives multiple inputs on the same port at the same time
b) when a component receives inputs on different ports at the same time
e) both of the above
f) none of the above

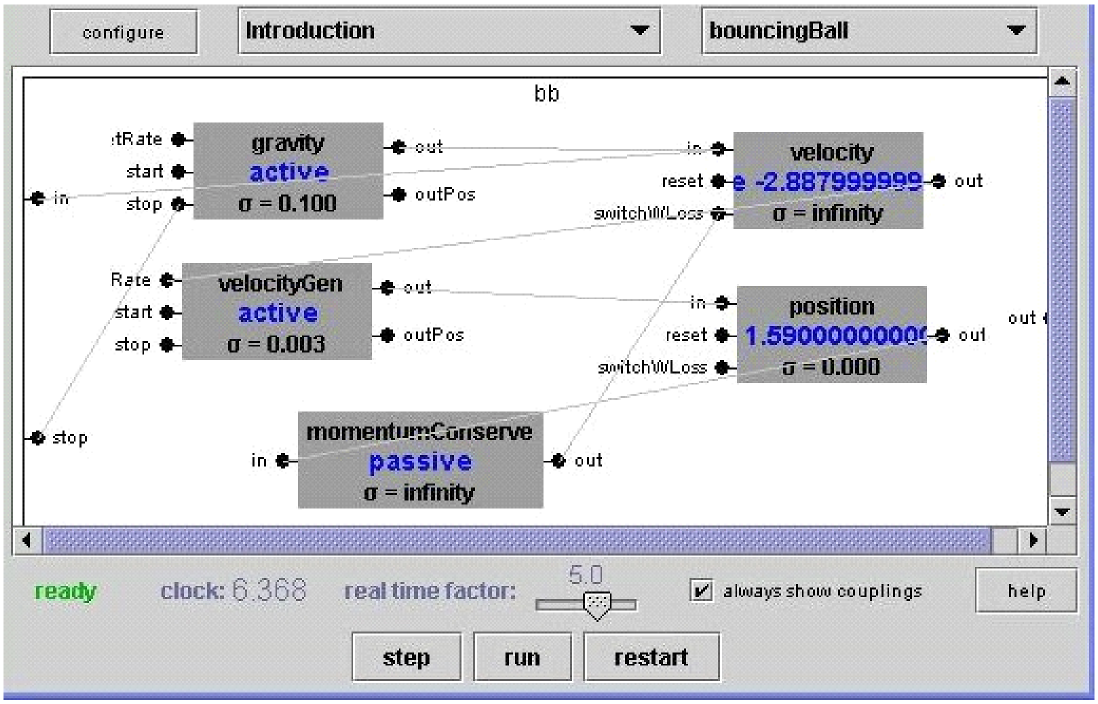
(circle the best answer)

12. The confluent transition function dictates how to handle

a) the priority order between the internal and external transition functions
b) internal and external events occurring at the same time

(circle the best answer)

13. If a component is imminent in simulation cycle then
  a) it will possibly generate an output
  b) it will undergo a state transition
  c) the state transition will always be dictated by the internal transition function
(circle all that apply)



14. In the coupled model shown above, all components have just been initialized using the restart button in SimView

Circle the components that are imminent:

1. gravity
2. velocity
3. velocityGen
4. position
5. momentumConserve

15. After pressing the step button, the clock reads

1. 0.003
2. 0.100
3. infinity
4. can't say with the information available

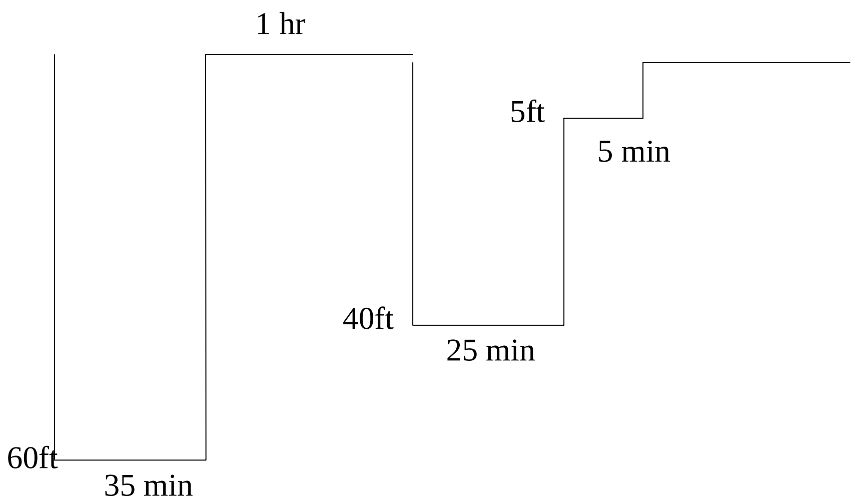
(circle the best answer)

16. Circle the components whose next event times are definitely known not to change after the pressing the step button

1. gravity
2. velocity
3. velocityGen
4. position
5. momentumConserve

Part II (30)

1. A scuba diver follows the dive plan shown below:



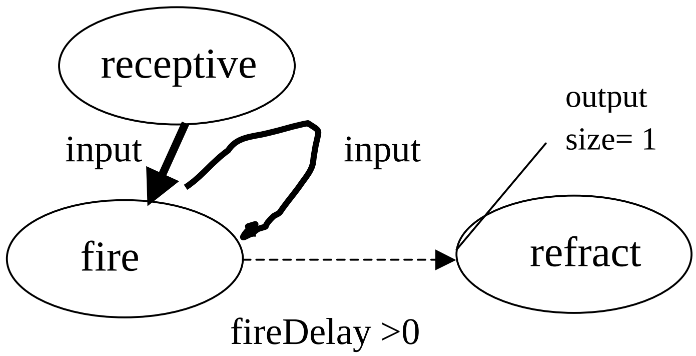
In words: she descends to 60 ft deep in a lake and stays there for 35 minutes; then rises to the surface and spends one hour resting. After this rest, she descends to a depth of 40ft and spends 25 minutes there. Finally, she rises to the 5 ft depth level and stays there for 5 minutes before coming up to the surface and never goes diving again.

Assume that you have an atomic model that represents this dive plan where the phases represent the depth levels. This model specifies the initialize(), deltint(), and out() functions only (and you need not write these down here).

Write deltext(...) and deltcon(…) functions so that at any time she is in the water, the diver can get a call on her (underwater enabled) cell phone telling her to leave the water. To leave the water she immediately ascends to the 5 ft level and stays there 5 minutes before rising to the surface and never goes diving again. Since the phone is for underwater emergencies only, she ignores any phone calls that come in while she is on the surface. Make sure to consider the cases where the confluent function might apply. Provide explanatory comments on your model code.

Part III (35)

For a fireOnce neuron (replicated below), if a second input pulse comes within the firing delay caused by a first input pulse, it has no effect. However, the model can be modified in the following ways



a) the second input pulse cancels the scheduled output pulse and sends the model to refract
b) the second input pulse cancels the scheduled output pulse and re-schedules this output after a time given by fireDelay.
c) the second input pulse causes the scheduled output pulse to occur earlier than it would have – the new time left to fire is equal to half what it would have been had no pulse arrived..
d) same as b) and in addition, the size of the output pulse is increased by an amount that equals the ratio of the interval between the arrivals of the two pulses to the time that was left to fire. This gives the output pulse "credit" for the cancelled pulse in proportion to how late in the firing phase it was aborted (near zero credit for nearly co-incident pulses; almost full credit (= 1) for a input pulse that comes almost at the end of the firing phase.).

a) Draw timing diagrams to illustrate how these modifications differ from the original. Make sure to show three successive, closely spaced, input pulses in each diagram.

b) Write the deltext(…) and out() functions for the fireOnce neuron and then write the deltext(…) and out() functions for each of the modifications.

c) In all cases, write deltcon() to ignore an input pulse coming in the end of the firing phase.

Solutions

A *Parallel Discrete Event System Specification* (*DEVS*) is a structure

$M = \langle X, S, Y, \delta_{int}, \delta_{ext}, \delta_{con}, \lambda, ta \rangle$

where

X is the set of input values

S is a set of states,

Y is the set of output values

$\delta_{int}: S \rightarrow S$ is the *internal transition* function

$\delta_{ext}: Q \times X^b \rightarrow S$

is the *external transition* function, where

$Q = \{(s,e) \mid s \in S, 0 \leq e \leq ta(s)\}$ is the *total state* set

e is the *time elapsed* since last transition

X^b denotes the collection of bags over X (sets in which some elements may occur more than once).

$\delta_{con}: Q \times X^b \rightarrow S$

is the *confuentl transition* function,

$\lambda: S \rightarrow Y^b$ is the output function

$ta: S \rightarrow \mathbf{R}^{+}_{0,\infty}$ is the *time advance* function

$DEVS_{scuba} = (X, Y, S, \delta_{ext}, \delta_{int}, \lambda, ta)$

where

$X = \{\}$

$Y = \{1\}$

S = {"sixty","forty","five","surface1 ","surface2"}$\times R_{0,,\infty}{}^{+}$

δ_{int} ("sixty",σ) = ("surface1",60)

δ_{int} ("surface1",σ) = ("forty",25)

δ_{int} ("forty",σ) = ("five",5)

δ_{int} ("five",σ) = ("surface2", ∞)

λ *(phase,*σ) = 1

ta (phase,σ) = σ

///

The phone call modification is

δ_{ext}(phase,σ,e,x) = *("five",*,5) if phase != "surface1" , "surfac2",or "5"

= *(phase,* σ*-e) otherwise*

δ_{con}(phase, σ,e,x) = δ_{ext} (phase,σ, e,x) //pay attention to external event (call)

//

FireOnceNeuron

$DEVS_{fireOce} = (X, Y, S, \delta_{ext}, \delta_{int}, \delta_{ext},, \lambda, ta)$

where

$X = \Re$

$Y = \Re$

S = {"receptive","fire","refract"}$\times R_{0,,\infty}{}^{+}\times R\}$

δ_{ext}("receptive",σ,size,e,x) = ("fire",fireDelay , size)

δ_{ext}("fire",σ,size,e,x) = ("fire",σ- e, size)

δ_{ext}("refract",σ,size,e,x) = ("refract",σ- e, size)

δ_{int} ("fire",σ,size) = ("refract", ∞, size)

δ_{con}(phase, σ,size,e,x) = δ_{int} (phase,σ,size)

λ ("fire",σ, size) = size

ta (phase,σ, size) = σ

initial state = ("receptive", ∞ ,1)

Modification a)

δ_{ext}("fire",σ,size,e,x) = ("refract",∞ , size)

Modification b)

δ_{ext}(“fire“,σ,size,e,x) = (“fire“,fireDelay, size)

Modification c)

δ_{ext}(“fire“,σ,size,e,x) = (“fire“,$(\sigma-e)/2$, size)

Modification d)

δ_{ext}(“fire“,σ,size,e,x) = (“fire“,fireDelay, size+ e/σ)

e) the second input pulse cancels the scheduled output pulse and sends the model to refract

$$\delta_{ext}(\text{“fire“},\sigma,\text{size},e,x) = (\text{“refract“},\infty,\text{size})$$

f) the second input pulse cancels the scheduled output pulse and re-schedules this output after a time given by fireDelay.

δ_{ext}(“fire“,σ,size ,e, x) = (“fire“,fireDelay, size)

g) the second input pulse causes the scheduled output pulse to occur earlier than it would have – the new time left to fire is equal to half what it would have been had no pulse arrived..

δ_{ext}(“fire“,σ,size, e, x) = (“fire“,$(\sigma-e)/2$, size)

h) same as b) and in addition, the size of the output pulse is increased by an amount that equals the ratio of the interval between the arrivals of the two pulses to the time that was left to fire. This gives the output pulse “credit” for the cancelled pulse in proportion to how late in the firing phase it was aborted (near zero credit for nearly co-incident pulses; almost full credit (= 1) for a input pulse that comes almost at the end of the firing phase.).

δ_{ext}(“fire“,σ,size, e, x) = (“fire“,fireDelay, size+ e/σ)